VALVE SYSTEM FOR INTERNAL COMBUSTION ENGINES

CROSS-REFERENCE TO RELATED APPLICATIONS, IF ANY

Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO A MICROFICHE APPENDIX, IF ANY

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention is a valve system for controlling the charging and exhausting of the combustion chamber(s) of internal combustion engines.

2. Background information.

This invention applies to charging and exhausting the combustion chamber(s) of internal combustion engines in an efficient manner.

Four stroke-cycle engines of common design breathe through two or more concentric poppet valves featuring angled seating areas. While modern engines have become much more efficient than previous examples by the incorporation of smaller included valve angles, increased valve area, and better port design, poppet valves by nature mask the ports which they control. In essence, the gas flow into and out of the combustion chamber must go around the head of the open valve(s) to

proceed through the port(s). This limits the volumetric efficiency of the engine. These valves are opened by radial lobes of a rotating camshaft. The base diameter of the camshaft lobes is largely dictated by the design valve lift, as the camshaft must ramp the valves open and closed smoothly, and at the proper time. To fit the timing constraints, the valves are ramped to full open, then ramped closed with essentially no duration at the full open position. To maintain smooth and properly timed valve actuation, significant increases in cam lobe base diameter are not possible with poppet valves. With the exception of desmodromic designs, high-rate springs are used to make the valves follow the profile of the camshaft lobes. These strong springs are required to control valve float at elevated engine speeds. Valve float causes the engine to run erratically, or even causes the valve(s) to destructively collide with the cylinder's piston. Each time the valves are opened, energy is expended to overcome the tension of the valve springs. The high spring tension also forces more robust design in related valve-train components. Known attempts to overcome these problems generally have had lubrication, oil control, and/or sealing issues.

Applicant has invented a valve system which lessens valve-port masking, opens the ports rapidly, has relatively long fully open duration, and also closes the ports rapidly. This system does not require that long-travel, high-rate springs be compressed. The asymmetrical valves of this system are palindromically controlled, and destructive valve float is eliminated. There is no unlubricated sliding or rotating motion, and oil control is the same as in conventional designs. A relatively larger diameter camshaft allows more precise valve actuation. The absence of long-travel, high-rate springs provides for the option of using electromechanical actuators in place of the camshaft.

SUMMARY OF THE INVENTION

The invention is a valve system to control the charging and exhausting of combustion chamber fluids of internal combustion engines. The valve system includes a cylinder head adapted for securing to a multi-level combustion chamber, the cylinder head including asymmetrical ports which open into the combustion chamber on separate levels. Each port is controlled by a valve member larger than the port, the valve member of similar shape as the port, each valve member providing a flat sealing area for contacting the port periphery. Each valve member has a non-centered cylindrical stem operatively traveling in a cylindrical valve guide sealed by a valve guide seal, each valve stem protruding through an end of the valve guide opposite the combustion chamber to locate a valve spring and accept a follower which captures the valve spring. Each follower is operatively associated with a valve operating assembly to selectively provide axial movement and rotational movement to each valve member and valve stem. The valve operating assembly first moves the valve member a nominal distance from the port periphery to unseal the port, then rotates the valve member in one direction to open the associated port, next rotates the valve member in an opposite direction to close the associated port, and finally moves the valve member a nominal distance to contact the port periphery and seal the port.

One embodiment of the valve system includes a specially designed cylinder head with two or more asymmetrical valve members with valve bodies shaped as needed to provide sufficient port area for the particular application. These valve members have conventional cylindrical stems which are offset from the center of the valve's body. The valve member's cover ports are shaped to match the valve's shape, with the ports somewhat smaller to provide a flat sealing surface completely around their periphery. Optionally, a matching seal, larger than the port, but smaller than the valve body, may

be fitted to the sealing area. The valve stems travel in conventional valve guides which are machined or pressed into the cylinder head, and which are sealed by conventional valve guide seals. The one embodiment of the valve system function as follows. A radial protrusion on an overhead camshaft, rotating at one-half crankshaft rpm, overcomes a valve spring and lifts the valve member a nominal distance off its sealing surface. Next, a circumferential groove on the camshaft acting on a follower, rotates the valve body to open the port, then rotates the valve member back to its original position to close the port. Once the valve member is back in its original position, the radial protrusion lowers the valve member back to its seated position. The camshaft diameter is not dictated by design valve lift and can be relatively larger to achieve desired valve member motion. A multi-level combustion chamber allows relatively larger valve and port area. The valve members can be larger than conventional designs, because they operate on different planes and don't interfere with each others path. In this design, the ports are oriented such that the valve guides are in line parallel with the crankshaft, allowing the use of a single camshaft driven by a simple chain or gear belt. Other designs with more valve members and multiple camshafts are possible, including separate camshafts for lift and for rotation.

In another embodiment of the invention, the camshaft(s) is replaced with electromechanical actuators. This is possible as the present invention features minimal valve spring force to overcome, as compared with conventional designs. In this embodiment, separate actuators for lift and for rotation open and close each valve member. The actuators can be solenoids, or solenoid controlled pneumatic cylinders. In the case of pneumatic actuation, air pressure is supplied by a pump powered by the engine and by a reservoir. Also, in this embodiment, continuously variable valve timing is provided by a control module acting on inputs such as crankshaft rpm, throttle position, inlet tract

vacuum and other operating parameters. The present invention is described for a single cylinder engine design. The valve system is also applicable to multi-cylinder engines.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the top of the invention showing the camshaft assembly and other features.

FIG. 2 is a perspective view of the bottom of the invention showing the combustion chamber and valves.

FIG. 3 is a plan view of the invention which shows the outside of the tubular spark plug cavity, the camshaft assembly, and the section line for FIG. 4.

FIG. 4 is a section view of the assembly which shows the valves seated at different levels, the ports, a valve guide, valve guide seal, valve spring, follower, and camshaft assembly with a circumferential groove.

FIG. 5 is an exploded perspective view of the top of the invention.

FIG. 6 is an exploded perspective view of the bottom of the cylinder head and valves, and shows the combustion chamber.

FIG. 7 is an enlarged perspective view of a valve stem showing the flat which registers the follower to the stem.

FIG. 8 is an enlarged perspective view of the combustion chamber with valves removed showing the port seals which may be used in this invention.

FIG. 9 is a perspective view of the inlet and exhaust port seals which may be used in this invention.

FIG. 10 is a section view of the valve seating area with a valve seal installed in a valve seal groove.

FIG. 11 is a perspective view of the bottom of the invention showing the combustion chamber with the inlet valve in the fully open position and the exhaust valve fully closed.

FIG. 12 is a perspective view of the bottom of the invention showing the combustion chamber with the exhaust valve in the fully open position and the inlet valve fully closed.

FIG. 13 is an exploded perspective view of the camshaft assembly showing the shaft, cam segments, and the setscrews which lock them in place on the shaft.

FIG. 14 is an enlarged perspective view of a cam segment showing a radial protrusion, circumferential groove, and the setscrew which locks the segment to the camshaft.

FIG. 15 is an enlarged perspective view of a follower showing the valve stem hole, driven pin, and the setscrew which locks the follower to the valve stem.

FIG. 16 is a perspective view of the top of the invention with electrotechnical actuators shown in place of the camshaft assembly and its related mounts and drive chain/belt opening.

FIG. 17 is a perspective view of one embodiment of the invention mounted to a cylinder block of an engine, the spark plug shown in a cutaway portion of the cylinder head.

DESCRIPTION OF THE EMBODIMENTS

Nomenclature

1 Cylinder Head

2 Valve Guide

3 Valve Guide Seal

4	Valve Stem
5	Camshaft Bearing
6	Tubular Spark Plug Cavity
7	Valve Spring
8	Follower
9	Camshaft Assembly
10	Camshaft Drive Sprocket
11	Camshaft Bearing Cap
12	Inlet Valve Member
13	Exhaust Valve Member
14	Threaded Spark Plug Hole
15	Inlet Port
16	Exhaust Port
17	Valve Seating Area
18	Opening for Camshaft Drive Chain or Belt
19	Camshaft Shaft
20	Camshaft Cam Segment
21	Circumferential Camshaft Groove
22	Radial Camshaft Protrusion
23	Follower Driven Pin
24	Follower Valve Stem Hole
25	Flat on Valve Stem

26	Exhaust Port Seal
27	Inlet Port Seal
28	Port Seal Groove
29	Follower Setscrew
30	Cam Segment Setscrew
31	Valve Lift Actuator
32	Valve Rotation Actuator

Construction

Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention, which may be embodied in other specific structure. The scope of the invention is defined in the claims appended hereto.

The invention is a mechanical assembly that includes a specially designed cylinder head **1** with a multi-level combustion chamber (Figures 4 and 8). A tubular spark plug cavity **6** opens to the outside of the cylinder head **1** and terminates in a threaded spark plug hole **14** in the attached combustion chamber. This tubular spark plug cavity **6** and threaded hole **14** accepts a spark plug (Figure 17) and isolates the plug from the inside of the cylinder head **1** to protect the plug from the engine lubricant which is prevalent in that area.

An asymmetrical inlet port **15** and an asymmetrical exhaust port **16** open onto separate levels of the combustion chamber, best seen in Figure 4. The inlet port **15** is covered and controlled by an inlet valve member **12** which is the same shape as the port **15**, but which is somewhat larger so that

the valve member **12** seats on a flat valve seating area **17** extending completely around the periphery of the port **15**. The exhaust port **16** is covered and controlled by an exhaust valve member **13** which is the same shape as the port **16**, but which is somewhat larger so that the valve member **13** seats on a flat valve seating area **17** extending completely around the periphery of the port **16**. An exhaust port seal **26** and an inlet port seal **27** may be fitted to the valve seating area **17**, as shown in Figure 8. These seals **26, 27** may be applied to the surface of the valve seating area **17** or may be fitted into a port seal groove **28** which is the same shape as the port, but is somewhat larger than the periphery of the port, as shown in Figure 10. The inlet valve member **12** and exhaust valve member **13** feature cylindrical valve stems **4**, which are offset from the center of each valve **12, 13**. Each of these valve stems **4** fits slidably and rotatably into a cylindrical valve guide **2** which is machined or pressed into the cylinder head **1** in an offset position, so that the closed valve members **12, 13** match and cover the ports and seats on the valve seating area **17**. The combustion chamber end of these valve guides **2** terminate a distance short of the valve seating area **17**, and the opposite end of the guides **2** protrude into the area below the camshaft assembly **9** so that a valve guide seal **3** can be fitted to each of them. When the valve members **12, 13** are in place in the valve guides **2**, the valve stems **4** protrude a distance through the valve guide seals **3** fitted to the guides **2**. Valve springs **7** are fitted over these valve stems **4**, valve seals **3**, and the protruding ends of the valve guides **2**. The valve springs **7** are each captured by a follower **8** which is fitted slidably onto each valve stem **4**. The followers **8** are registered to the valve stems **4** by flats **25** on the stems **4** and corresponding holes **24** with flats in the followers **8**. A set screw **29** in the follower **8** secures the follower **8** to the valve stem **4**.

Referring now to Figures 1 and 5, a camshaft assembly **9** is fitted rotatably into camshaft bearings **5** in the cylinder head **1**. It is captured by camshaft bearing caps **11** which are fastened to the

cylinder head **1**. This camshaft assembly **9** is located by the camshaft bearings **5** so that the cam segments **20** are in position to act on the followers **8** as the segments **20** rotate. The camshaft assembly **9** is driven in rotation by a chain or gear belt (not shown) which acts on the camshaft drive sprocket **10** which is fixed non-rotatably to the camshaft **19**. The camshaft assembly **9** rotates at one-half crankshaft speed in a four-stroke-cycle engine and at crankshaft speed in a two-stroke-cycle engine. The chain or gear belt travels in an opening **18** in the cylinder head **1**. With the camshaft assembly **9** in place, the follower driven pins **23** are engaged in the circumferential camshaft grooves **21** of the cam segments **20**. The follower driven pins **23** have an axis a selected distance from the valve stem **4**, providing leverage to rotate the valve stem **4** and associated valve member **12, 13**. A nominal clearance between the follower **8** and the cam segment **20** is present when the radial camshaft protrusion **22** is not in contact with the follower **8**. This clearance is adjusted by sliding the follower **8** to the necessary location on the valve stem **4** and then locking the follower **8** in place with the follower setscrew **29**.

The camshaft assembly **9** is constructed such that adjustments can be made to alignment with the followers **8** and so that valve timing can be varied individually. The camshaft cam segments **20** fit slidably and rotatably onto the camshaft assembly shaft **19**, as shown in Figure 13. The cam segments **20** are moved to the desired locations on the camshaft assembly shaft **19**, then locked in place by cam segment setscrews **30**.

The function of this embodiment is as follows: A radial protrusion **22** on a cam segment **20** which is part of a camshaft assembly **9** rotating at one-half-crankshaft-rpm presses on a follower **8** which overcomes a spring **7** and lifts a valve member **12** or **13** a nominal distance from the valves seating surface **17**. A circumferential groove **21** on the same cam segment then acts on the driven pin

23 of the follower **8** to rotate the valve member **12** or **13** to its fully open position. After a period of dwell, the circumferential groove **21** acting on the driven pin **23** of the follower **8** rotates the valve member **12** or **13** back to its closed position. The radial protrusion **22** then lowers the valve **12** or **13** back to its seated position on the valve seating area **17**. As the camshaft assembly **9** rotates, the other valve member **12** or **13** is likewise actuated at the proper time to provide suitable charging and exhausting of the combustion chamber.

Alternatively, electromechanical means may be used to actuate the valve members **12, 13,** replacing the camshaft assembly **9**, camshaft bearings **5**, camshaft bearing caps **11**, and the camshaft drive sprocket **10**. In this embodiment shown in FIG. 16, the followers **8** are pressed by valve lift actuators **31** which are mounted to the cylinder head **1**, to lift the valve members **12, 13**. Once the valve member **12** or **13** is lifted, the valve member **12, 13** is then rotated open and closed by a valve rotation actuator **32** mounted to the cylinder head **1**, acting on the follower driven pin **23** of the follower **8**. The valve **12** or **13** is then lowered by the valve lift actuator **31**. As in the first embodiment, the valve members **12, 13** are actuated at the proper time to provide suitable charging and exhausting of the combustion chamber.

The cylinder head and valve system of the present invention is intended for use in place of the common and well known poppet valve cylinder head of internal combustion engines. Some details of the engine, such as the cylinder and piston, are equally well known and are therefore not shown or discussed in this construction. Provisions for cooling and for supplying lubricant to the camshaft, bearings, etc., while necessary in an actual working engine, are not shown or discussed in this description, as common methods such as coolant passages and oil pipes or passages are both well known and understood.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.